No. LVI.

Observations on the foregoing communications, by B. Henry Latrobe, Surveyor of the public buildings of the United States, and one of the Committee to whom it was referred by the Society.

Copying the English standard, the bricks of the United States are very generally made $8\frac{1}{2}$ inches long, $4\frac{1}{4}$ inches broad, and $2\frac{1}{4}$ inches thick; so that in the wall with the joint, they shall take up nine inches in length, and half as much, viz. $4\frac{1}{2}$, in breadth; but the various degrees in which different sorts of clay shrink in drying and burning, occasion here, as well as every where else, variety in the size of the bricks; and I have scarcely ever known bricks, from two different kilns in the same city to work correctly together. The cupidity of the brick-makers contributes also to the diminution of the size of bricks in Philadelphia; a wall two bricks thick seldom measures, with the joint, more than 17 inches; a brick-and-half wall, barely 13 inches, and 5 courses in heighth, with the joints, measure one foot.—This gradual diminution in the size of bricks is rather encouraged, than counteracted, by the interest of the bricklayers:—for, as it is the general practice for individuals, as well as public bodies, to find all their materials, and to pay the mechanic only for the labour, and as it is a very general practice to pay the bricklayer by the 1000 bricks, according tot he brick-maker's account; or to count them on the outside of the wall, where they all pass for whole bricks and lie closest, it follows that in a given mass of wall, the small bricks, upon the whole, tell better than the large ones; and in both cases, especially the first, the bricklayer is not interested against admitting small bricks to be made.

On the other hand, the brick-maker in burning his bricks as well as in selling them by count, is benefitted; for small bricks can be burned at less expense of fuel than large bricks, and are less liable to warp and break. I am of opinion that great advantages would result from making our bricks larger than the usual standard; not only in the saving of labour, but of mortar, which here, as in India, is the most expensive part of the wall. The width of a brick should not be greater, than that a man can very easily and conveniently grasp it; and although Mr. William Jones has not given information as to the width of the Calcutta brick, (which is of more importance to the workman than its length) I am of opinion that the best possible size of a brick is the following,

11 inches long as in Calcutta,	when burned.
$5\frac{1}{4}$ wide	
$2\frac{1}{4}$ thick.	

Such a brick would add $2\frac{1}{2}$ inches to our single brick walls, and in most cases permit them to take the place of walls now built of $1\frac{1}{2}$ bricks. A brick-and-half wall, in the fronts of our middling houses, would give room for the window-dressings and shutters; and, in a two-brick wall, there would be no necessity of making thicker the walls of our best houses for this purpose. This is not the place to enter into further details. Practical builders can easily investigate the results from such a change in the size of our bricks; but it will be difficult to be effected, while the astonishing increase of our buildings gives to the brick-makers such an influence over all our building operations.

1 *Use of brick dust in mortar.*

In his answer to the 8th Query, Mr. William Jones has the following remark:

The bricks contain much sand, salt, alkali, and other fusible matter, and will vitrify before they are well burned.

We might then consider the brick dust, made by pounding the bricks of Calcutta, as so much *sharp sand,* and as having lost that *contractility* which *clay* unvitrified by the admixture of vitrescible substances, and unhardened by fire, universally possesses. In this state, it might be an unobjectionable ingredient in cement in America. But as it is evident from the process of laying on the chunam internally, and also from the beating required upon the materials of their terraces, that their brick dust is not generally in this hardened state, when mixed with the mortar, but that it continues to contract, and to require forcible compression by beating or rubbing until it is quite dry, it becomes, on more than one account, a very noxious as well as a very inconvenient ingredient in all cements, to be used where there is frost, and where labour is dear.

I should be obliged to write a voluminous treatise on this subject, were I to submit to you all that my experience, as well as my reasonings suggest, to counteract the prejudice in favour of the use of brick dust in cements north and south of the tropics. Its utility beyond the reach of frost, I need not examine. It would be useless to establish or to refute it in our region of severe winter. I will therefore only endeavour to comprize, in as small a compass as possible, what may be useful to our own citizens.

Belidor, Blondel, Sturm, Smeaton, Higgins, Adams, and many other French, German, English and Italian writers have all recommended brick dust in some cement or other. I have none of their works at hand, so as to refer to their receipts or their experiments, and no doubt their cements have possessed all the qualities ascribed to them, when the brick dust has been prepared of well burned bricks. I have also seen brick dust employed by engineers and architects whom I have personally known, and have employed it myself; but I do not recollect a single instance of the cement in which it has been used having resisted the effect of moisture and frost. Natural argillaceous stones are more apt to be forced to pieces by frost than any others.* Bricks not sufficiently burned are always destroyed by frost. The effects of frost on the natural clay of the earth is well known,—it renders our roads almost impassable in spring. It seems therefore, to plain sense, a conclusive argument against the use of this material in cements, that wherever we see it present in any natural or artificial production, its dissolution by frost is certain.

* The freestone of Acquia, however, appears to be sand cemented by an alluminous (argillaceous) infusion. Some of it is dissolved by the frost, but the best stone resists it most perfectly. Water oozing through this stone covers the face of the rock with allum. I have not been able to detect in this sand stone any particle of calcareous matter. Its smell when moist is strongly earthy. See my memoir in the Philosphical Transactions, on this stone. page 283 of this Volume.

If however the clay be hardened by being converted into a vitrified, or otherwise solid brick, then indeed it ceases to be under the dominion of frost, and is at all events, I should suppose, as good as so much sand. It remains to be enquired by chemical investigation, whether some affinity between clay, thus hardened, and lime does not exist, which expelling in their union their caloric, combines the two substances more intimately and in a smaller compass, than that of lime mixed with sand; and, of course, gives to the compound more hardness, and permanent continuity. If such affinity does exist, which I will not *deny*, such brick dust is so far superior in quality, as an ingredient of cements, to sand. But it is, I think, far counterbalanced by its other quality of infinite contractibility and expansion. Clay, in its purest state, is used in Wedgewood's pyrometer, on account of this very quality, which it appears never to lose; and from thence arises the perfection of this most useful instrument. When the cement, of which brick dust is an ingredient, is laid on in a moist state, it occupies in some cases (for I have last year had much unpleasant experience of the fact in the floors laid in Deniroth's cement at Washington) $\frac{1}{6}$ more space than when dry. On a wall exposed to heat, or upon a timber floor accessible, and at first pervious to the air, there appears to be a limit to the contraction of the cement. But in a heavy vaulted building, like the Capitol of the United States, at least, the moisture of which evaporates slowly, I would reject brick dust altogether as an ingredient of any kind of cement, either for mosaic floors, terraces, or facings. Full justice appeared to be done by the contractor and patentee, in beating his floors both as to time and labour, but after a year's drying they have cracked into innumerable fissures.

From what I have said, it will be evident, that I consider brick dust as an ingredient in cements, inapplicable to our climate and of course useless.

Good clean washed sand, and stone lime, in the proportion of three of sand and one of lime, up to six to one, according to the size of the particles of sand, and the goodness of the lime, is a cement that will never fail, if well mixed and worked, and laid on as soon as possible after being mixed. The lime in slacking should be perfectly drowned in water, and the fluid strained and run into a pit, from whence, after remaining if necessary during a whole winter, or more, it may be cut out hot, as smooth as custard, and capable of receiving a very great proportion of sand without becoming harsh and brittle. All substances containing a quantity of carbon combined with oxygen, are highly useful ingredients; such as *skim-milk*, *whey*, molasses, skimmings of sugar pans, sugar, vinegar, beer, wine lees, all sorts of washings of breweries, distilleries, and sugar houses. These substances, by giving their carbon to the lime, convert the cement into a calcareous sand stone in a more expeditious manner, than by any process dependent upon attraction from the atmosphere. But though blood, oils, and curds have been recommended, the animal or vegetable mucilage they contain is injurious to their durability. The celebrated cement of Adams, of which oil was a considerable ingredient, after standing with every appearance of permanence for some years, began then to fail, and actions being brought against him by Lord Stanhope (Mahon) and others upon his warrantee, this artist, so deservedly considered as one of the brightest ornaments of the English school, was ruined in fortune, by the damages awarded against him.

Before I close my remarks on this cement, I will add, that all cements of every kind acquire the quality of hardening in proportion to the working and beating they get, and no remark can be more just than that of Mr. Jones, that "the patience bestowed will amply reward you."

2. *and* 3. *Use of Timber in Walls.*

In all professions, there are prejudices of practice, which become national. That of filling their walls with what they call bond timbers is one of those practices, which every English architect receives by inheritance. The white ants have been serviceable to architecture in expelling it from Bengal.

A piece of timber bedded in a wall can be of service, only for the following uses:

1. If it be laid under the joists or timbers of a floor, it serves to spread the weight equally along the wall; or if under the

end of a girder, to give to the girder a broad base or bearing upon the wall.

2. To tie the wall together lengthwise, in order to prevent its spreading at the top.

When the foundation is equal, it is evident that bond timbers become useless, excepting in the first case.—But it has been customary in England to put them regularly into the walls, from the bottom to the top, at the distance of several feet asunder; taking care that one piece shall be laid so as to receive the skirting, another the surbase, &c.—A specimen of this practice might have been seen in the north wing of the Capitol, in which the bond timber had a considerable share in the failure of the work, and in the necessity of a thorough rebuilding of the interior.

Bond timbers do injury by the following means: A piece of timber laid along the wall, takes up in its whole length the place of solid materials. It is laid in wet mortar; and the work above, as the moisture descends, keeps it wet for some time. It swells. It is on three sides inaccessible to the air. At last it dries with the wall and shrinks. If the timber occupies less than half the thickness of the wall, the wall will not follow it, the outer part being the heaviest, but the timber occupying less space than before, becomes loose. In heavy buildings, being moist and excluded from the air for a long time, it will probably be rotten before that time. The plaistering that covers it will crack. In fact, if it ever was useful, it ceases entirely to be so.

To prevent these timbers from moving outwards as they get loose, they have some times been made thicker within the wall than on their exterior side, sometimes they have been tied in by short cross pieces. But all this does not remove the evil.

As to the convenience of bond timbers for fastening on the the dressings—the same end may be much better accomplished by driving in very dry oak plugs, after the building is finished and dry.

If however the foundation be unequal, it is evident that the tendency of one part of the wall to sink into a soft place while the rest is supported by a harder part of the foundation can only be resisted by timber strong enough to hold up the wall that is over it. This is very inadequately done by timbers lying at distances from each other only on the inside of the work. Where there is such a foundation, it is infinitely better to combine the strength of all these timbers, and, laying them in the trench, to cover them well from the access of air, and build the wall upon them. But piling is always the best thing that can be done even if no very hard bottom can be reached.—Bond timbers ought never to be depended on.

I have already extended my remarks to a length which I did not intend or foresee—and yet I cannot avoid adding to them what I think necessary to meet the inclination, supported by our Italian prejudices, which the very clear and able manner in which Mr. Jones has described the Hindoo method of constructing terraces might excite, to make further experiments on the construction of flat roofs for our American houses.

In crowded cities, where the court yards are generally small and buried from the light and air by tall houses, terraces on the roofs are almost *necessary*, for the view and enjoyment of the heavens, and for many domestic purposes. But they are every where, excepting beyond the region of frost, the most difficult and precarious part of the construction of the house. Lead, copper, sheet-iron, tarred and sanded paper, calcareous cements, all have been tried, all have had temporary success, all have produced permanent inconvenience. The range of the expansion and contraction of lead, together with the range through 100 degrees of Fahrenheit's thermometer, to which our climate is subject, renders lead an improper metal for the purpose of a terrace. It is liable to be torn to pieces by its own motion.—Copper is very expensive, and is soon corroded by verdigrease. Iron requires constant painting, is sooner corroded by rust, but is otherwise the most convenient material and the cheapest.—Sand, tar, and paper, succeed better to the north-eastward, than in the middle and southern States, but is not easily or securely to be connected with gutters, and is a dirty sort of covering.—Calcareous cements have in no instance as yet succeeded, and the smallest crack, admitting water in winter. during the frost, is fatal to them.

Fortunately, we have no rational use for flat roofs. Our cities are roomy, and our habits and their population will for many centuries keep them so. Our houses are low and our yards airy. I cannot conceive a single argument in favour either of the beauty or utility of terrace roofs in our country. Those that have them scarcely ever use them. The cold in winter and the heat in summer drive us from them. A beautiful prospect may justify the partial use of them, in particular situations, but neither architectural beauty, nor the general wants of our wintry climate call for their introduction.—To the southward beyond the reach of frost, however, the information contained in this paper may be highly useful.

No. LVII.

A general method of finding the roots of numeral equations to any degree of exactness; with the application of Logarithms to shorten the operation: by John Garnett of New Brunswick N. Jersey.

Read January 20th, 1809.

Suppose an equation, $ax+bx^2+cx^3+dx^4+ex^5$ &c. $=v$, to find x.

RULE.

Find, by trial, any near root as x'.

Then, by substitution, $ax'+bx'^2+cx'^3+dx'^4+ex'^5$ &c. $=v'$
Multiply each term by the index of the power of x', and divide by x'.
Let the products, $a+2bx'+3cx'^2+4dx'^3+5ex'^4$, &c. $=A$.
Multiply each term by the power of x', and divide by $2x'$.
Let the products, $b+3cx'+6dx'^2+10ex'^3$, &c. $=B$.
Multiply each term by the power of x', and divide by $3x'$.
Let the products, $c+4dx'+10ex'^2$, &c. $=C$.
Multiply each term again by its power of x', and divide by $4x'$.
Let the products, $d+5ex'$, &c. $=D$: and so on, continually, until all the powers of x' are destroyed; so that e, &c. $=E$.

Then will $Ax''+Bx''^2+Cx''^3+Dx''^4+Ex''^5$ &c. $=v-v'$, be a *New Equation* whose roots will all be less by x', and the value, $v-v'$, less by v' than the roots of the original equation. And if the roots and value of this new equation be diminished in the same manner, by another near root, as x''', and so on, continually, the root and value may become less than any assignable quantity, and the sum of all the near roots will be equal to x, the root of the original equation.